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Title

Automatic cutting of digital multi-field radiographs into single images

Authors

Thies C,

Department of Medical Informatics, Aachen University of Technology, Aachen, Germany

Molander B,

Department of Oral and Maxillofacial Radiology, Göteborg University, Göteborg, Sweden

Gröndahl HG,

Department of Oral and Maxillofacial Radiology, Göteborg University, Göteborg, Sweden

Lehmann TM,

Department of Medical Informatics, Aachen University of Technology, Aachen, Germany

Abstract

Aims

Conventional x-ray equipment for extraoral imaging, such as Scanora and Cranex Tome (Soredex, Helsinki, Finland) that is fed with digital sensor plates produces image files composed of up to eight individual image fields. In this study, an automatic detection and cutting algorithm is evaluated.

Methods

Automatic decomposition is based on row and column histograms. Since the image fields are not sharp-edged and the separating gaps vary in width as well as grayscales, three criterions were verified. Normalized histograms are computed for the sum of gray scales, the variance, and the entropy to detect horizontal and vertical gaps. The algorithm tries to find at first a maximum in the column histograms that indicates two rows of image fields. Thereafter, the same procedure is applied to the row histograms to detect neighbored frames within the row.

To determine the gap position, all maxima of each histogram are computed and the positions of the maxima are analyzed. If they lie at positions equidistantly dividing the length of the histogram, these positions correspond to gaps. To reflect slight variations in the intensity of the gap, the position may vary within five percent of the histogram length from the equidistant interval boundaries. Additional information is given by the number of equidistant intervals that have to be tested. For instance one vertical cut is allowed maximally. This test performed for each of the three histograms where all of them must yield the same cut position.

A set of 1878 images was selected arbitrarily from a department of dental radiology, reflecting the frequency of the imaging procedures applied to the patients. Sensitivity and specificity are computed and analyzed for different geometrical pattern of image field compositions (e.g., 1-1, 1-2, 1-3, 2-2, 2-3 for rows and columns, respectively).



Results

Pattern	no	detected by automatic image analysis						errors
		2/2	2/1	1/4	1/3	1/2	1/1	
2/2	34	22	9	---	---	3	---	12
2/1	50	---	49	---	---	---	1	1
1/4	3	---	---	3	---	---	---	0
1/3	55	---	---	---	44	---	11	11
1/2	279	---	---	---	---	264	15	15
1/1	1457	---	17	1	3	9	1427	30
sum	1878							

421 of the images acquired directly digital consist of more than one image field, which are placed in one or two rows of up to four elements. The following errors occurred. 12 (2.9%) and 27 (6.4%) of images to be cut were only partly or not separated at all, respectively. From those images showing only one image field, only 30 (0.2%) were erroneously split in two or more parts. Over all, a sensitivity and specificity of 90,7% and 97,9% is obtained, respectively.

Conclusions

Digital imaging has become the standard in dental radiology and allows the compilation of large archives. Frequently, the direct digital images are composed of several panels placed within a unique matrix of pixels, although a staple of frames would be more suitable to handle and process this data. Applying our simple but efficient algorithm, these data can be detected, decomposed and rearranged automatically. This allows further processing and imaged analysis such as content-based retrieval.

